STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME V

STANDARD OPERATING PROCEDURES FOR AIR QUALITY MONITORING

APPENDIX O

GLOBAL POSITIONING SYSTEM

MONITORING AND LABORATORY DIVISION

AUGUST 2002

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OPERATING PROCEDURES

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O.1.0 INTRODUCTION

As part of the Air Resources Board (ARB) ongoing program to pinpoint and validate the location of all air monitoring sites in California, the ARB has employed the use of Global Positioning Systems (GPS). The GPS is a portable, battery operated instrument capable of providing accurate latitude, longitude, and altitude data 24 hours a day. Auditors for the Quality Assurance Section (QAS), verify the site locations while conducting field performance audits.

O.1.1 GENERAL INFORMATION FOR THE GARMIN GPS

General Discussion Concerning the Proper Operation of the Global Positioning System - This section will describe basic information and instructions that are important for the proper use of the Garmin GPS 12 Global Positioning System. For more detailed information or instructions, refer to the operations and maintenance guide located with the GPS.

1. The GPS is an all weather, portable navigation device which receives satellite based radio signals to determine the time of day, position, distance from locations, speed of haul, direction and time of arrival at a destination.

2. The GPS is a twelve channel receiver that can track up to twelve satellites. In addition, the GPS can be set up in one of three transportation modes; land, sea, or air to optimize receiver dynamics for land, sea, or air navigation. The system will ensure worldwide operation with 24 hour coverage.

3. The GPS can take from one second to five minutes to gain the initial fix (the position that is determined from two or more satellites that project radio signals that are converted by the GPS to a format that can be used for finding an unknown position) depending on the distance that the GPS has been moved since it was turned off. The GPS will update the position every second.

4. For best results, use the GPS in open areas away from objects that could disrupt or block the radio signals being emitted by the satellites.

5. Battery life: The GPS 12 operates on the use of 4 AA batteries and will provide up to 24 hours of continuous use. A battery level indicator can be found by navigating to the satellite page of the GPS, located to the left of the 'sky view'. Ensure batteries have a sufficient charge before use (at least 25% charge). If batteries have a low charge, they **MUST** be changed as accuracy is severely affected. Be sure to follow the polarity guide on the battery pack when inserting new batteries. Before removing the battery pack, ensure the unit has shut down.

   WARNING: Improperly inserting the AA batteries in the battery pack will damage the internal memory of the GPS.

   CAUTION: Prolonged exposure to direct sunlight may create very high internal temperatures which can reduce the life of the internal memory backup battery.

   WARNING: Always be sure the unit's power is off when connecting external power or changing the battery pack.

6. Altitude information is only accurate to within ± 500 feet.

O.1.1.1 MODES OF OPERATION

The GPS has eight modes of operation, from which the operator can choose to perform virtually all navigational activities. Press one of the buttons for the desired mode (see Figure O.1.1.1).

1. OFF: The GPS goes through a 15 second countdown before going completely off.

2. POS (position): Time, Date, Latitude, Longitude, Altitude, and type of fix.

3. NAV (navigation): The NAV mode assists in navigating from one waypoint to another. The GPS will give TO, FROM, and XTE (cross track error) information.

4. TIME: The time mode gives time in reference to a 24 hour clock, the date, ETA (estimated time of arrival), TTG (time to go – to endpoint or destination), and the time of the last fix.

5. WPT (waypoint): The waypoint mode is used to enter or change specific fixes which may be kept in the GPS's internal memory. The waypoints can be used in conjunction with either the NAV or TIME mode.

6. DIST (distance): The DIST mode calculates the distance and bearing between any two waypoints.

7. STS (Satellite Tracking System): This mode gives the status of the satellites being tracked.

8. SET UP: Used only when setting the initial GPS settings or when downloading the waypoint library.

O.1.1.2 INITIAL FIX

The GPS provides fixes in either two-dimentional (2D) or three-dimentional (3D) position solutions. If the GPS is receiving signals from four or more satellites, it has a 3D fix and is accurate in latitude, longitude, and altitude. If the GPS is only receiving signals from three satellites, it will only be accurate in latitude and longitude. A 3D fix is the most desirable fix.

1. Navigate to the Satellite Page using the 'PAGE' or 'QUIT' keys (see Figure O.1.1.1).

2. Allow time for a fix to occur. When a fix has occurred, the top left of the display screen will read '2D Diff', '3D Diff', or if no fix has occurred due to poor coverage, the screen will display 'POOR CVG' (see Figure O.1.1.1.).

   NOTE: For the most accurate latitude and longitude information with an '2D Diff' fix, you must manually enter the altitude.

O.1.1.3 WAYPOINT

A waypoint is a positional fix that has been stored in the GPS internal library with a specific label assigned by the GPS or operator. Up to 500 waypoints can be created, displayed, edited or deleted with the GPS. The following steps must be taken to manually store and assign a specific label to the fix.

1. Press the 'MARK' key after gaining an initial fix (see Figure O.1.1.1). The position page will appear, with a default three-digit name for the new waypoint in the upper-left portion of the page.

2. To save the waypoint, scroll to highlight 'SAVE' and press 'ENTER'.

3. To rename the waypoint, highlight the waypoint name and press 'ENTER'.

4. Using the 'UP' arrow key to move forward through the alphanumerical characters and the 'DOWN' arrow key to move backwards, enter the first letter of the site name followed by the site number.

5. In addition to renaming the waypoint, a default symbol is assigned to each waypoint saved. To change the symbol, highlight the waypoint symbol field, and press 'ENTER'.

6. Select the desired symbol using the 'UP' and 'DOWN' arrow keys.

7. Press ‘ENTER’ and scroll to highlighted text, ‘DONE?’ and press ‘ENTER’.

O.1.1.4 COMPASS

The GPS is equipped with a compass. The following procedures should be taken to gain an accurate compass reading:

1. Press the ‘GOTO’ button.

2. Highlight any waypoint.

3. Press ‘PAGE’.

The compass page will appear with an electronic ‘compass ring’.

O.1.1.5 ROUTES

The route navigation feature enables the operator a planned course from one place to another using a set of pre-defined waypoints. Routes are further broken down into legs, the segment between two waypoints. The GPS allows the storage of up to 20 routes, each consisting of up to 30 waypoints. Routes can be copied, cleared, inverted, and activated. Consult the GPS manual for further details on clearing, inverting or activating routes. The following steps must be taken to create a route.

1. Highlight ‘ROUTES’ from the Main Menu Page and press ‘ENTER’.

2. Highlight the route number field, and press ‘ENTER’.

3. Enter a route number, and press ‘ENTER’.

   NOTE: Select an empty route without any waypoints listed when creating a new route.

4. Enter the first waypoint of the desired route and press ‘ENTER’. Continue entering waypoints until desired route has been completed.

5. The default route name can be changed by highlighting the route and pressing ‘ENTER’. Using the ‘UP’ and ‘DOWN’ arrow keys, navigate through the alphanumerical characters until the desired name has been selected.

O.1.1.6 GPS DATA REPORTING

Each time a waypoint is saved the GPS adds that waypoint to the internal library. GPS waypoints of sites are then entered (and if necessary, updated) into the QAS site survey, enabling easy access to site survey information for individual monitoring sites. Included are the longitude, latitude and altitude of the site. Site surveys are updated, as new information becomes available.

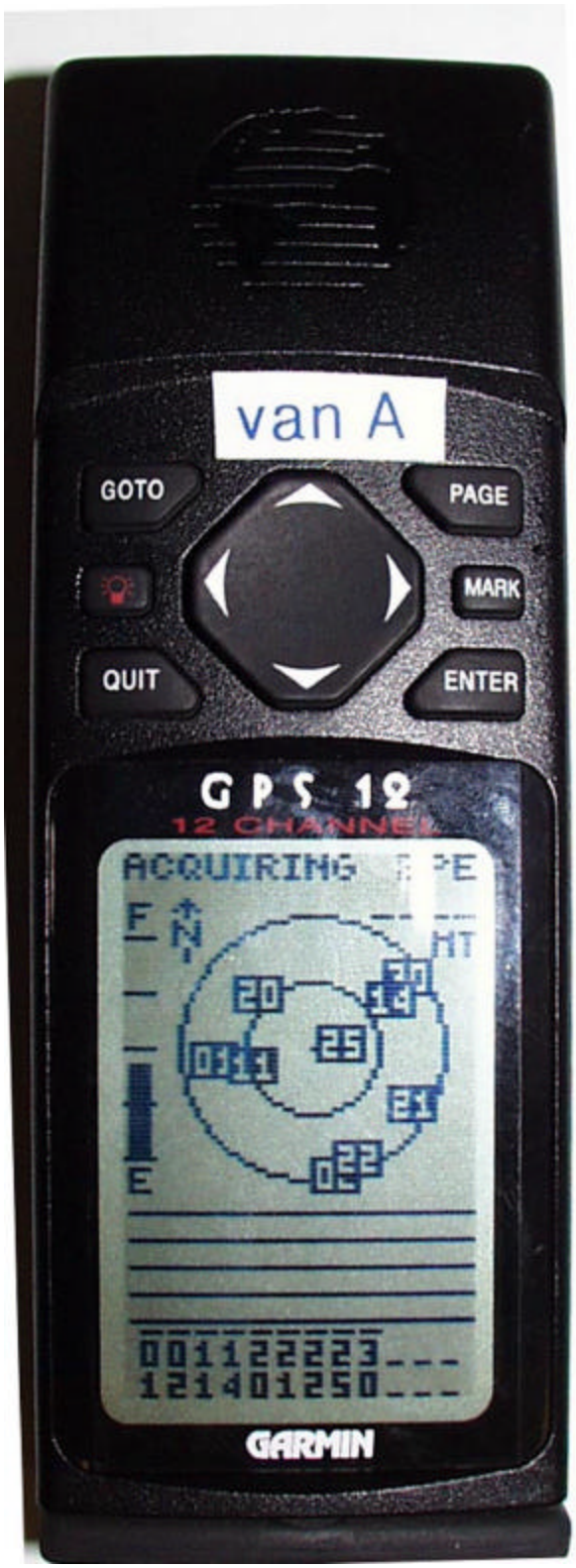

Figure O.1.1.1
GPS Display Screen and Control Panel

O.1.2. GENERAL INFORMATION FOR THE MAGELLAN GPS

General Discussion Concerning the Proper Operation of the GPS 3000 XL Global Positioning System - This section describes basic information and instructions that are important for the proper use of the Magellan GPS 3000 XL Global Positioning system. For more detailed information or instructions, refer to the Magellan Users Guide.

1. The GPS is an all weather, portable navigation device which receives satellite based radio signals to determine the time of day, position, distance from locations, speed of haul, direction and time of arrival at a destination.

2. The GPS is a five channel receiver capable of tracking 12 satellites with an internal library. The system will ensure worldwide operation with 24 hour coverage.

3. The GPS can take from one second to five minutes to gain the initial fix (the position that is determined from two or more satellites that project radio signals that are converted by the GPS to a format that can be used for finding an unknown position) depending on the distance that the GPS has been moved since it was turned off. The GPS will update the position every second.

4. For best results, operate the GPS with the antenna positioned vertically away from objects that could disrupt or block the radio signals being emitted by satellites.

5. Battery life: The GPS operates on the use of 4 AA batteries and will provide up to 24 hours of continuous use. The battery icon will show up on the bottom left corner as a warning of low battery power. The receiver will operate for an additional 30 minutes before automatically turning off. Ensure batteries have a sufficient charge before use (at least 25% charge). If batteries have a low charge, they **MUST** be changed as accuracy is severely affected. Be sure to follow the polarity guide on the battery pack when inserting new batteries. Before removing the battery pack, ensure the unit has shut down.

WARNING: Improperly inserting the AA batteries in the battery pack will damage the internal memory of the GPS.

CAUTION: Prolonged exposure to direct sunlight may create very high internal temperatures which can reduce the life of the internal memory backup battery.

WARNING: Always be sure the unit's power is off when connecting external power or changing the battery pack.

6. Altitude information is only accurate to within ± 500 feet.

O.1.2.1 MODES OF OPERATION

The 3000 XL has two types of keys (see Figure O.1.2.2): function keys and operation keys. The function keys access the unit's main features. The operation keys are used for power up, power down, lighting and to scroll through information on the display. The alphanumeric keys are used to input information and to change settings.

1. Function Keys

   a. ON/OFF: Holding this key allows the device to be turned on or off.

   b. GOTO: The Goto key allows you to establish a one or multi-leg route from the present position to any stored waypoint or unnamed coordinate.

   c. NAV: The NAV key provides both navigation (heading, bearing, and distances) and velocity (speed over ground) information. Navigation information is available only when waypoints and routes have been entered and the route has been activated. There are 4 different navigational screens each with a distinct set of information displayed.

   d. LIGHT: The LIGHT key controls activation of the display light when the unit is on. To deactivate, the display light, press the LIGHT key.

   e. MNU: The MNU key stands for 'MENU' and gives access to various functions regarding the operation and storing of waypoints, fixes, routes, odometer, setup, memory clearing, and satellite status.

   f. CLR: The CLR key is used to exit a pop-up menu without performing an action.

   g. ENTER: The ENTER key performs the menu choice highlighted.

2. Main Menu Options

a. WPT MENU: The waypoint mode is used to enter or change specific fixes which may be kept in the GPS's internal memory. Up to 200 waypoints can be stored on the 3000 XL.

b. LAST FIXES: The 3000 XL automatically records fixes every 10 minutes (up to 21 fixes) while operating. This function allows viewing, saving, and deleting of last fixes in the 'LFIX buffer'.

c. ROUTE MENU: The Route Menu is used to view a one-page list of up to five existing routes (composed of a series of pre-selected waypoints). A pop-up menu allows the activation, deactivation, reverse, edit or delete of the selected route, or viewing selected legs of the route.

d. ODOMETER: This feature keeps track of total distance traveled in addition to trip distance.

h. CLEAR MENU: The clear menu function is used to delete last fixes, track, waypoints and routes, or everything in the receiver's memory.

O.1.2.2 INITIAL FIX

When the receiver is first turned on, the start-up screen appears, followed by the Position screen. The Position screen appears with the word 'Searching' followed by a bar graph indicating the GPS device is receiving current GPS data from the satellites.

A position fix is displayed as soon as enough satellite data is available for one to be calculated. The first fix should occur in approximately one minute but can take as long as fifteen minutes if the unit has been moved a distance greater than three hundred miles or if it has not been used for six months. The 3000 LX will provide the same types of satellite fixes (2D and 3D) as described in Section O.1.1.2 Initial Fix.

1. Press the ON/OFF button on the keypad. The unit will go through a self-test. If the unit has either been moved a distance greater than 300 miles while turned off, or has experienced a deletion of memory, the unit will have to be reinitialized. Please see manual for details on initializing.

2. The Position screen should appear. The word 'Searching', followed by a bar graph indicating GPS data is being received from the satellites.

3. A 'lock' icon will appear in the bottom left corner of the screen indicating the 3000 XL has locked onto satellite signals. In addition, a '2D' icon **may** be present, indicating a 2D fix.

   NOTE: A 3D fix has been achieved when the '2D' icon is absent from the screen.

O.1.2.3 WAYPOINT

The 3000 LX can store and edit two hundred waypoints (see Section O.1.1.3 for waypoint definition). The following steps must be used to store and assign a specific label to a position fix so that it can be stored as a waypoint.

1. Obtain a position fix following the steps described in Section O.1.2.2.

2. After gaining an initial fix, press the ENTER button (from the Position or any NAV page).

3. A cursor will appear, where a name for the waypoint can be entered, using the UP/DOWN, RIGHT/LEFT arrow keys.

4. If ENTER is pressed without creating a name, the receiver assigns a default waypoint name. Waypoint names assigned by the GPS receiver appear in the following format, WPTxxx, where the 'xxx' is a sequential number (001 up to 200).

O.1.2.4 COMPASS

The GPS is equipped with a compass. The following procedures should be taken to gain an accurate compass reading:

1. Select a waypoint destination after pressing the 'GOTO' button.

2. Press the 'NAV' button until the 'plotter' screen appears.

O.1.2.5 ROUTES

The route navigation feature enables the operator a planned course from one place to another using a set of pre-defined waypoints. Routes are further broken down into legs, the segment between two waypoints. The GPS allows the storage of up to 5 routes, each consisting of up to 20 waypoints. Routes can be copied, cleared, inverted, and activated. Consult the GPS manual for further details on clearing, inverting or activating routes. The following steps must be taken to create a route:

1. Press 'MENU', 'DOWN ARROW' and highlight 'ROUTE MENU', followed by 'ENTER' to access the Route Menu.

2. The Route menu screen should appear. Highlight an empty route and press 'ENTER'.

3. The 'From' item will be highlighted. Using the left and right arrow keys, scroll through available waypoints to set as the departure site.

   NOTE: If a current fix has been obtained, it will be represented by '-STRTx' (where 'x' represents the route number).

4. Press the down arrow key so that the 'To' item is highlighted. Following the same procedure for the 'From' item, select a destination waypoint for the current leg.

5. Press 'ENTER'. The screen will now display 'LEG 02' of the route. Following steps 3 and 4, continue creating the remaining legs of the route.

6. When a route has been completed, press 'ENTER' with the 'To' field blank.

   NOTE: The route will now be activated. To deactive route, access the Route Menu, highlight the route to be deactivated using the up and down arrow keys and press 'ENTER' two times.

O.1.2.6 GPS DATA REPORTING

Each time a waypoint is saved the GPS adds that waypoint to the internal library. GPS waypoints of sites are then entered (and if necessary, updated) into the QAS site survey, enabling easy access to site survey information for individual monitoring sites. Included are the longitude, latitude and altitude of the site. Site surveys are updated, as new information becomes available.

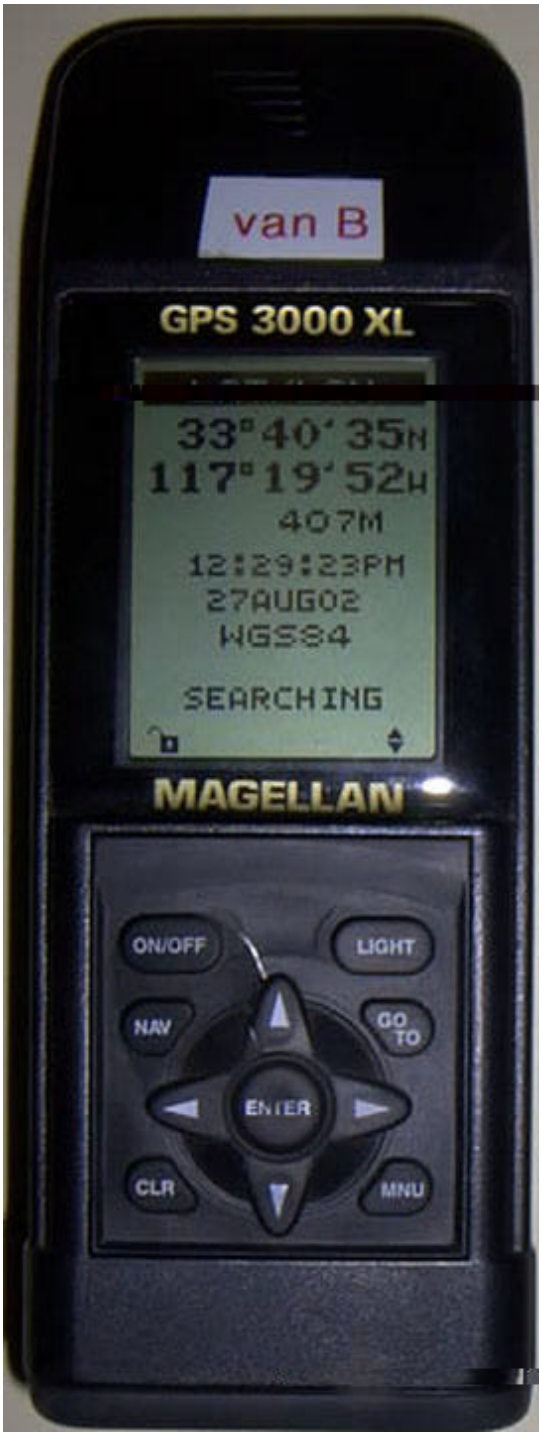

Figure O.1.2.1
GPS Display Screen and Control Pad